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Using Matching Grants to Facilitate Corporate-University Research Linkages: A Preliminary Examination of Outcomes From One Initiative

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ABSTRACT

In the 1980's the issue of corporate-university linkages has received markedly increased attention from governments, corporations, and universities. From governments perspective, the drive to enhanced corporate-university linkages is derived from the belief that these linkages will contribute to economic competitiveness. One method that has been used by government to encourage this interaction is through the provision of matching grants. Using public finance theory as the conceptual basis, the paper examines the preliminary outcomes of one government's matching grant initiative. Through a compilation of data on university research revenues on corporate contract research and a questionnaire to companies that placed the research contracts in universities, the paper shows that matching grants, in the manner provided by the BILD program, may not be an effective mechanism to promote corporate-university research linkages. The paper concludes with some suggestions for further research and discusses the conceptual and methodological hurdles that can be encountered when attempting to assess the outcomes of a matching grant program, particularly as applied to corporate-university linkages.

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RÉSUMÉ

Au cours des années 80, les gouvernements, les corporations et les universités ont accordé une attention accrue à l'action réciproque entre le milieu universitaire et celui des affaires. Du point de vue gouvernemental, cette action réciproque allait favoriser la compétitivité économique. Une des méthodes utilisées par les gouvernments est celle de la distribution de subventions à parts égales. À partir de concepts théoriques empruntés au milieu financier, l'auteur évalue le programme de subventions pour la recherche développé par le gouvernement ontarien pendant la période de 1981 à 1983. Les deux sources d'information utilisées sont (1) des données sur les revenus universitaires approuvés pour la recherche effectuée de façon contractuelle entre le milieu universitaire et celui des affaires et (2) un questionnaire rempli par les compagnies qui ont participé à ces contrats de recherche. Les résultats démontrent une efficacité mitigée de ce programme. Le projet de recherche conclut en formulant quelques suggestions pour des recherches ultérieures et présente une analyse des problèmes conceptuels et méthodologiques susceptibles d'être rencontrés lors de l'évaluation de programmes d'action réciproque, particulièrement entre le milieu universitaire et celui des affaires.

1.0 INTRODUCTION

Issues involving the relationships between the university and the business corporation have received markedly increased attention in recent years from governments, corporations and universities. In Canada, from the perspective of the federal and provincial governments, the enhancement of corporate-university linkages is viewed as a means to an end – namely, favourably positioning the economy to compete successfully internationally and increasing the supply of new jobs. From the university perspective, the increased attention is a result of stagnation in the traditional sources of university revenues – the federal and provincial governments – and the expectation that increased corporate support would not only augment resources, but also provide a means of restoring public confidence in universities, and therefore, ultimately, increase public funding. From the corporate perspective, much of the increased attention is a result of recent discoveries of significant commercial importance in university laboratories.[1]

The recent renewal of interest on corporate-university linkages has led to a proliferation of literature on the topic. On the one hand, much of the literature is either of a descriptive nature, where the various types of linkages are described, or of an exhortative nature where the pros and cons of becoming involved in corporate-university linkages are examined from various perspectives (Baldwin and Green, 1984-85; Fairweather, 1989). On the other hand, with a few exceptions (Gray, Johnson, Gidley, 1987; U.S. General Accounting Office, 1988; NSF, 1986), there has been little discussion of, or empirical data obtained on, the

effectiveness or outcomes of goverment programs to promote corporate-university linkages.

In 1981, the Government of Ontario announced the creation of the Board of Industrial Leadership and Development (BILD). One set of activities subsumed by BILD was a program of matching research grants to the universities of Ontario. The program was in effect for the fiscal years 1981-82 and 1982-83, and had a budget of $5 million. The BILD matching research grants program[2] was designed to facilitate increased interaction between corporations and universities by encouraging university faculty to seek *new* research and development contracts with industry that would facilitate technology transfer activities (BILD, 1981-82).

The purpose of this paper is to describe and analyze the effort on the part of the Ontario government to affect the behaviour of Ontario universities by offering matching grants for industrial research contracts. Since the program was in operation for only two fiscal years, and had a $5 million budget, it would be inappropriate to draw any substantive conclusions or generalizations about effects. In this respect this effort is presented as a preliminary examination of outcomes from one matching grant initiative. With that in mind, this paper will discuss a number of relevant questions: What were the outcomes of the BILD initiative? Did the program alter the behaviour of Ontario's universities and professors by providing an incentive to seek *additional* corporate research contracts, that is, more corporate research contracts than they would have had in the absence of grant aid? Did the program have an effect on industry in influencing companies to contract for research in a university environment? Was the existence (or possibility) of a matching grant a major factor which influenced the company to undertake the research in a university environment? The paper will conclude by describing a number of areas for future study.

2.0 CONTEXT

In Canada, there seems to be a consensus emerging among government, industry and universities, that knowledge and people are two of the main components in achieving economic growth. According to this consensus, universities, as creators and disseminators of new knowledge, as well as providers of highly qualified manpower, have a crucial role to play in the economic development process. The creation of effective links between knowledge creators and knowledge users is seen as essential to our future as a nation. This point has been emphasized by a number of important bodies.

In a recent report of the Science Council of Canada (1988), which was based on a number of background studies on corporate-university linkages, this theme was emphasized by its Chairman, Dr. Geraldine Kenney-Wallace.

> The underlying theme of this Science Council report is that to compete internationally we must cooperate nationally. We need to integrate people, ideas, opportunities, markets, and capital in new and effective ways. The most urgently needed linkages are those between the research community within the universities

> and the private sector. A new sense of strategic partnership must become a reality ... The onus is on our scholars to transfer ideas and results from the laboratory and library to the national and international marketplace, and on the private sector to build upon this knowledge bank (pp. ix–x).

The final report of the Commission on the Future Development of the Universities of Ontario (1984), the Bovey Commission, called for closer links between corporations and universities.

> The development of closer and more effective linkages between corporations and universities is essential to facilitate not only the production of more technology as a direct result of new knowledge, but its diffusion and application within industry (p. 5).

A national body of chief executive officers and university presidents, the Corporate-Higher Education Forum, has also called for closer ties between corporations and universities. The Forum, created in 1983, is designed to allow selected senior business executives the chance to interact with selected university presidents to discuss issues of mutual interest. The Forum commissioned a survey on the extent of corporate-university linkages in Canada (Maxwell and Currie, 1984). In their report, Maxwell and Currie state that economic forces in the 1980's are drawing universities and corporations together.

> Canada's ability to promote rising living standards is threatened because vigorous international competition is forcing a continuing shakeout in a number of key resource and manufacturing industries ... These industrial challenges mean that Canada must pursue a more rapid rate of advancement in knowledge; it must mobilize intellectual and financial resources in order to achieve excellence in research and effective technology transfer from all sources. In short, economic forces are drawing the corporate and academic communities together (p. 1).

The thrust of the Science Council report and background studies, the Bovey Commission report, the publications of the Corporate-Higher Education Forum, and coverage in the popular media suggest that the extent of corporate-university linkages should be increased, and many governments have determined that corporate-univesity linkages is a concept worth encouraging with public funds.

3.0 BILD MATCHING RESEARCH GRANT PROGRAM

The Ontario government description of the BILD program (BILD, 1981-82), contains many of the same economic themes that exist in publications of the Corporate-Higher Education Forum, the Science Council of Canada and in the popular print media.

> Its major purpose is to encourage universities and their faculty to seek new research and development contracts with the industrial sector. It is also hoped that such contracts will facilitate the successful transfer of research results from the university laboratory to industrial production in the future and thereby contribute to the continuing development of the province (p. 1).

Ontario universities that held contracts with corporations between October 1980 and September 1981 were eligible to submit applications for consideration of

Table 1

BILD Matching Research Grants Competition 1981-83

University	$ Amount 1981-82	% of Total	$ Amount 1982-83	% of Total
Brock University	12,000	.68	12,000	.48
Carleton University	12,000	.68	28,000	1.12
Guelph University	45,800	2.58	167,100	6.68
Lakehead University	44,000	2.48	16,500	.66
McMaster University	202,600	11.40	475,800	19.03
University of Ottawa	32,500	1.83	41,700	1.67
Queen's University	150,300	8.46	217,700	8.71
University of Toronto	566,300	32.99	644,600	25.78
University of Waterloo	613,200	34.51	778,600	31.14
University of Western Ontario	72,000	4.05	75,900	3.04
University of Windsor	6,400	.36	42,100	1.68
Total	1,777,100	100.00	2,500,000	100.00

Source: University Relations Branch, Ministry of Colleges and Universities

matching funds. The matching grant selection was made by a committee of academic and industrial scientists, although their recommendations had to be confirmed by the Minister of Colleges and Universities. A maximum of $50,000 was awarded to any one contract and contracts were limited to the natural sciences and engineering. The matching grants were made available for many purposes including the purchase of equipment, equipment operating and maintenance costs, and the salaries of graduate students, research assistants and technicians.

In 1981-82, the committee spent only $1.7 million out of the $2.5 million government allocation (Table 1). This was, in part, a result of a sparsity of applications as the program was announced late in fiscal year 1981-82 (although not all applications received funding). The University of Toronto and the University of Waterloo combined, received 68% of the total allocation. The 1982-83 competition expended the full budget of $2.5 million as the program had had time to become publicized in the university community, and research administrators at universities had more time to inform professors of the availability of the matching grants. Professors also had a year of lead time to seek out and negotiate new contracts with industry.

The 1982-83 allocations found some universities doing better than in 1981-82. For example, the data in Table 1 indicate that between 1981-82 and 1982-83, McMaster University increased its share of the total allocation from 11.4 percent to 19.0 percent, and the University of Guelph increased its share from 2.6 percent to 6.7 percent. The proportion allocated to the University of Toronto and the

University of Waterloo, the universities with the largest engineering faculties, decreased to 57 percent from 68 percent.

In a letter to the Presidents of Ontario universities, formally informing them of the 1982-83 program, the Minister of Colleges and Universities stated that the matching program would not be continued for fiscal year 1983-84, and that the Industrial Development for Employment Advancement Corporation (IDEA) would be addressing corporate-university linkages as part of its mandate.[3]

4.0 CONCEPTUAL FRAMEWORK

The conceptual framework of this paper is derived from the discipline of economics and public finance. Public finance theory proposes various rationales for grants from one level of government to another level of government.[4] The rationale for the availability of a matching grant that is appropriate for this paper is the enforcement of grantor preferences for merit goods[5]. For the purposes of analysis, this paper treats the positioning of the Government of Ontario as analogous to a central government in a federal system and the universities of Ontario as analogous to local autonomous governments. Matching grants may be made by the grantor (Ontario Government) in order to encourage grantees (Ontario universities) to adjust the pattern of overall spending to be more closely in line with the preferences of the grantor. Musgrave (1976), states that "the services in question are considered meritorious by the grantor, who believes grantees should provide them at a higher standard than they would have in the absence of grant aid" (p. 628).

All of the stated rationales for intergovernmental transfers have one thing in common – they treat the recipient of the revenue (the lower level of government) as analogous to individuals and/or firms for the purpose of achieving the stated objectives. This is a limiting factor when it comes to assessing the effectiveness of intergovernmental grants in achieving their objectives because governments represent many individuals – individuals whose preferences do not always coincide. The literature has taken this factor into account through the development of various models that attempt to explain government behaviour in reacting to intergovernmental transfers. Slack and Crocker (1985) outline four different types of models –political, bureaucratic, setter, and interactive – each of which deals with this problem in a different way.

Econometric studies of intergovernmental grants explain statistically how grants affect the expenditures of the grantee. Bird and Slack (1986, p. 111–112), and Slack and Crocker (1985, p. 322) describe the results of various empirical studies on the effects of intergovernmental grants on recipient behaviour. Notwithstanding this limiting factor, the intergovernmental grants literature is in agreement with the proposition that the provision of an open-ended matching grant may increase the overall level of that particular service as the grant alters the price of the aided good. The precise stimulative effect of a matching grant will depend on the price elasticity of demand for the aided good and the matching level (income

effect). There is the theoretical possibility that there will be a decrease in the provision of the aided good (substitution effect). Once again, the assumption is that the income and substitution effects that individuals may make as choices, are transferable to governments acting for aggregate groups of individuals.

5.0 PROGRAM ASSESSMENT

There are two major caveats that must be taken into account if the BILD program is to be assessed using an intergovernmental grants framework. The first caveat is that the matching grant available through the BILD program was not consistent with public finance principles for interfering with grantor preferences – Universities which had corporate research contracts had to *apply* for a matching grant and there was no guarantee they would *receive* the matching portion. In this respect, the BILD program was not conceptually pure, and instead represented the selective subsidization of research projects. The second caveat is that the eventual successor to the BILD program, the University Research Incentive Fund (URIF), which has been operating since November 1984, awards matching research grants to universities. The original criteria for the URIF program was markedly different from the BILD program as the URIF program required a matching rate of two corporate dollars to one government dollar, social sciences and humanities professors were not excluded from submitting contracts for consideration, and the $50,000 maximum award amount was removed. Using this criteria, by October 1985, 29 corporate research projects had been approved for matching funds of $3,283,336. However, the program was non-operational from October 1985 to September 1986, pending evaluation. In September 1986 the URIF program was re-established as part of the Premier's Council Technology Fund and the matching rate was changed to a rate of 1 to 1. Using this criteria, by May 1988, 215 corporate research projects had been approved for matching funds of $17.8 million. While the URIF program differs significantly from the BILD program in terms of eligible contracts and the maximum size of grants awarded, the one common denominator is that, like the BILD program, universities had to *apply* for a matching grant – there was no guarantee that they would actually receive the matching portion. Therefore, it is difficult to determine the long term effects of the BILD program in isolation from the URIF program.

In order to determine whether the BILD program altered the behaviour of Ontario universities, or influenced companies to contract for research in a university environment, data from two sources was gathered: (1) historical data on university revenues from corporate contract research from 1980-81 to 1984-85; and (2) a questionnaire was developed and administered to companies that university researchers used as sponsors for the matching grant.

Fiscal year 1980-81 was used as the baseline year because it was one year before the BILD program was implemented and would illustrate a year of normal activity without financial incentives. Fiscal year 1983-84 was used as the upper limit year, because it was one year after the BILD program was terminated and the URIF program had not yet begun.

Table 2

Estimate of Corporate Contract Research in Ontario Universities, 1980-81 to 1987-88*

	Total Revenue $000	Total Sponsored Research $000	Contract Research Big Six $000	Contract Research All Uni. $000	Constant Dollars	Index ***
1983-84	2,114,083	309,502	7,321*	8,228**	8,228	1.000
1982-83	1,943,265	274,338	6,233*	7,005**	7,381	.949
1981-82	1,678,724	251,246	4,905*	5,531**	6,256	.884
1980-81	1,476,369	195,790	3,341*	3,856**	4,808	.802

Source: COFOU 1980-81 to 1983-84. * Contract Research Data from University of Toronto, University of Waterloo, McMaster University, Queen's University, University of Western Ontario, and University of Guelph. ** Estimated contract research for all universities based on big six undertaking 90% of all corporate contract research. *** Index is COU Research Index.

Some universities derive a larger portion of their research revenues from contract research than others. For example, in 1987-88, corporate research contracts represented 2.87 percent of total sponsored research at Ontario universities, 11.56 percent at the University of Waterloo, 4.42 percent at Queen's University, 1.98 percent at the University of Toronto, 4.94 percent at McMaster University, .89 percent at the University of Western Ontario and .94 percent at the University of Guelph.[6] Since these universities account for the majority of corporate contract research in Ontario, these universities were asked to provide data on this activity from 1980-81 to 1983-84[7], which is contained in Table 2.[8]

5.1 Ontario University Research Revenues 1980-81 to 1984-85

The data indicate that corporate contract research increased from $3.8 million in 1980-81 to $8.2 million in 1983-84. To take inflation into account, the Council of Ontario Universities (COU) research index was applied to the data. In constant dollars, corporate contract research increased $1.448 million from 1980-81 to 1981-82, one year before the implementation of the BILD program, $1.125 million from 1981-82 to 1982-83, and $.847 million between 1982-83 and 1983-84, one year after the BILD program expired. The data clearly illustrate that as the program was implemented, the yearly rate of increase in corporate contract research declined. However, on closer inspection, the $1.448 million increase between 1980-81 and 1981-82 cannot be attributed to the possible stimulative effects of the matching grants as the grants were announced and implemented late in fiscal year 1981-82. The $1.125 million increase between 1981-82 and 1982-83 may be attributable to the matching grants but the $.847 million increase between

1982-83 and 1983-84 is certainly not attributable because no matching grants were made in 1983-84. Thus the evidence on the possible stimulative effects of the grants is contradictory. There was a larger increase in the rate of growth of contract research in 1980-81 to 1981-82 ($1.448 m) when there should have been no stimulative effect, compared to the 1981-82 to 1982-83 period ($1.125 m) when the grants were in full force, and 1982-83 to 1983-84 ($.847 m) when there were no grants. This illustrates that there may be other factors, in addition to the availability (or possibilty) of a matching grant, which influence the rate to which universities accept corporate contract research or companies are prepared to buy contract research at universities.

Since this paper focuses on the effects of one small specific matching grants initiative, data on corporate contract research in Ontario universities after 1983-84 is not included in the analyses because it is impossible to separate any long-term stimulative effects of the BILD program from the short and long term stimulative effects of the URIF program.

5.2 Survey and Survey Results

The intent of the questionnaire was to determine the characteristics of sponsoring companies involved in university contract research, the factors that may have influenced an individual company's decison to undertake the research project in a university environment, the extent of corporate involvement in different types of corporate-university linkages, the extent of company spending on R & D, and company perceptions on the effectiveness of the BILD program.

In order to determine the survey population, each university was contacted and asked to provide a list of faculty and companies that participated in the BILD program. Most universities were able to provide a list of grant recipients, but a compilation of company addresses and contacts was much more difficult to amass as the application to the BILD program never asked for a company contact name or company address.[9] Therefore, the 167 matching grants awarded in 1981-82 and 1982-83 were analyzed, and contact was attempted with each grant recipient to ascertain a company contact name and address, which resulted in a survey population consisting of 65 sponsoring companies. This was a result of elimination of companies who had more than one research contract with universities, unavailable addresses, defunct companies and the fact that some professors had left their positions to go to other universities outside Ontario and Canada, others had moved to industry, and others did not even want to talk about their industrial research activities.[10] Twenty-seven of 65 companies answered the questionnaire for a response rate of 41.5 percent.

The data derived from the survey are specific to a select group of companies – those whose research contracts at Ontario universities from 1981 to 1983 were awarded matching grants. The activities of these companies would not necessarily reflect, nor necessarily be representative of, the activities of all research and development (R&D) performing companies in Canada. For example, the size of

Table 3

1st and Second Most Important Factors in Influencing Company to Undertake Research Project at University

		1st Most Important %	2nd Most Important %
1.	Availability and expertise of a specific professor.	53	15
2.	Previous research completed in the area by professor(s) concerned.	15	30
3.	Proximity of institution to company	0	11
4.	Qualified specialists for such research not on staff of this company/organization.	15	15
5.	Company/organization does not possess specialized equipment or laboratory space for such research.	0	7
6.	Availability of a specific piece of testing equipment at the university.	0	0
7.	Prestige of university	0	0
8.	Availability (or possibility) of a matching grant to support the project.	7	15
9.	Previous consulting arrangement with professor(s)	4	4
10.	Other	7	4

N=27

companies participating in the BILD program does not reflect the general population of R&D performers in Canada[11] since a sizeable number of small companies participated. Forty-four percent of companies had less than 250 employees, 11.1 percent had between 251-1000 employees, 29.6 percent had between 1001-5000 employees, and 14.9 percent had over 5000 employees.

When asked what the two most important factors were that influenced their company's decision to undertake the university based research project, 53 percent stated that the most important factor was the availability and expertise of a specific professor (Table 3). Fifteen percent stated that previous research was completed in the area by the professor concerned and 15 percent stated that qualified specialists for the research were not on staff at the company. Only 7 percent stated that the availability (or possibility) of a matching grant to support the project was the first most important factor. For the second most important factor, 30 percent stated that previous research was completed by the professor in the area, 15 percent stated the availability and expertise of a specific professor, 15 percent stated that qualified specialists for the research were not on staff at the company, and 15 percent stated that the availability (or possibility) of a matching grant to support the project was the second most important factor.

Table 4

Sponsoring Company Involvement in Types of Corporate-University Linkages

	Yes %	No %
Faculty Consulting	81.5	18.5
Research Grants	44.4	55.6
Affiliate Program	22.2	77.8
Personnel Exchange	22.2	77.8
Incubator/Research Park	8.7	91.3

N = 27

The extent of company involvement in different types of corporate-university linkages is presented in Table 4. The data indicate that formal corporate-university linkages is well advanced. Eighty-two percent of companies had consulting arrangements with faculty, 44 percent of companies awarded general research grants, 22 percent of companies were involved in an affiliate(s) program, and 22 percent of companies exchanged personnel.

The survey also illustrated that most companies had comprehensive R&D programs. Thirty percent of companies spent less than $1 million of R&D, 19 percent spent between $1 million and $5 million and 33 percent spent over $5 million. The size of the R&D department (scientists and support staff) varied – 18.5 percent of companies had between 1-5 personnel, 7.4 percent had between 6-10 personnel, 11.1 percent had between 11-25 personnel, 7.4 percent had between 26-50 personnel, 18.5 percent had between 51-100 personnel, 7.4 percent had between 101-150 personnel and 14.8 percent had over 150 personnel in their R&D department. Only 15 percent of companies did not have an R&D department. In addition to their in-house R&D expenditures, 79 percent of companies contracted out for research with 59 percent spending $.5 million or less on this function.

When asked to indicate the extent to which their company had increased their contract research involvement with universities in the period 1983-1988, 33 percent indicated that contract research with universities had increased significantly, 18.5 percent had increased marginally, 22 percent had stayed the same, 7 percent had decreased marginally, and 11 percent had decreased significantly. Of those companies who indicated that contract research with universities increased significantly or increased marginally (52 percent), 57 percent indicated that this increase would have occurred without the matching research grant program. This means that 30 percent of the survey population increased their contract research activity but not necessarily as a result of the BILD program. Only 21 percent indicated that the increase in contract research would not have occurred without the program. This means that only 11 percent of the survey population increased their contract research expenditures as a result of the BILD program.

5.0 DISCUSSION

The two questions the paper seeks to answer is the degree to which Ontario universities attracted more corporate contract research than they would have in the absence of grant aid and the degree to which the availability (or possibility) of a matching grant influenced industry to undertake research in an Ontario university. The conceptual framework illustrates that the provision of a matching grant may increase the supply of the aided good – in this case corporate contract research at Ontario universities, because the price of the aided good has declined. However, as was previously noted, a major caveat in assessing the BILD program within an intergovernmental grants framework is that the BILD program was not consistent with public finance principles for interfering with grantor preferences – Universities which had corporate research contracts had to *apply* for a matching grant and there was no guarantee they would *receive* the matching portion. Because of this characteristic, any possible stimulative impact in terms of changing a university's behaviour, according to the framework outlined, may be severely muted.

The data presented in Table 2 indicate there has been real growth in corporate contract research revenues in Ontario universities, although the precise stimulative effect of the matching grants seems to be only one of many factors that influence the rate of growth of corporate contract research. For example, *ceteris paribus*, the rate of growth in contract research was higher between 1980-81 and 1981-82, when there should have been no effect, compared to between 1981-82 to 1982-83, when the matching grants were in place. Analyzing the data from another perspective, matching grants as a percentage of *total* university corporate contract research revenues in 1981-82 and 1982-83 were 31 percent and 36 percent respectively. This suggests that the *actual* matching rate for the BILD program was not 1 for 1 as stated, but 1 to approximately .34. In intergovernmental grant theory and practice, this represents a significantly reduced financial incentive to the universities of Ontario in securing new industrial research contracts. If a matching rate of 1 for 1 was instituted and made available on *all* corporate research contracts, Ontario universities would probably respond in a different manner as there would be a larger subsidy available. In 1987-88, a matching level of 1 for 1 for all corporate research contracts in Ontario universities would have cost the Ontario Government $12 million.

The secondary question that the paper has attempted to address is the degree to which the BILD program had an effect on industry in influencing companies to contract for research in a university environment. Only 7.4 percent of companies indicated that the availabilty (or possibility) of a matching grant was the first most important factor in undertaking research in a university environment. Fifteen percent stated that it was the second most important factor. Moreover, of those companies that increased their contract research with universities after the expiration of the program, only 21 percent (11% of total population) indicated that this increase would not have occurred without the program. This suggests that for

the majority of the sponsoring companies, the availability (or possibility) of a matching grant, barely factored into their decision to undertake the research in a university environment.

One salient point that the company questionnaire illustrated was that companies engaged in contract research with universities because of the availability and expertise of a *specific* professor. Since few companies stated that research contracts emanated from a previous consulting arrangement, companies sought out the expertise they needed. This finding suggests that if universities and government are serious about increasing corporate-university linkages in terms of contract research, it is important for universities to undertake inventories of their faculty expertise and disseminate this information to corporations. The notion requires further study, but this preliminary analysis suggests that an appropriate role for the Ontario government may be the co-funding with Ontario universities of the undertaking and dissemination of inventories of faculty expertise. This has already occurred in the United Kingdom.[12]

6.0 IMPLICATIONS FOR FURTHER RESEARCH

The BILD program was the first attempt by the Ontario Government to stimulate corporate-university research linkages. As stated previously, because the program was small ($5 million budget) and of short duration (2 years), it would be inappropriate to draw any substantive conclusions about possible effects without further research that would include the URIF program and possibly the Federal Government's matching grants initiative. Thus, the analysis and conclusions presented above must be interpreted as a preliminary examination of outcomes from one matching grants initiative.

The Ontario Government's stated objective in the BILD program was to stimulate *new* corporate research contracts in Ontario universities. Therefore, the success of the BILD program, and the subsequent URIF program, should be assessed in the context of the extent that *additional* corporate research contracts (over and above what Ontario universities would have attracted in the absence of grant aid) were secured. Assessed in the context of public finance and matching grant theory, the BILD and URIF program are not conceptually pure. The incentive to universities generally, and to individual professors specifically, to change their behaviour is muted. The matching grants are not given to all corporate research contracts that Ontario universities secure, but only to selective corporate research contracts. This fact alone explicitly changes the focus of the program's objectives from attempting to increase the overall amount of corporate contract research undertaken in Ontario universities, to the subsidization of selected corporate research projects. Selective subsidization of corporate research projects may be laudable, but if this is the intended focus, it should be stated up front.

The conceptual framework that the paper utilizes is applicable to a longer term assessment of the BILD and URIF programs combined, although, as stated previously, the URIF program has been substantially altered compared to the

BILD program, probably making any combined assessment fruitless. Whether BILD and URIF are analyzed together or separately, there are conceptual and methodological limitations that must be taken into account. For example, in this study, one conceptual limitation is that it uses an intergovernmental grants framework which assumes that the recipient of the revenue (the lower level of government or in this study universities) is analogous to individuals and/or firms for the purpose of achieving the stated objectives. Governments represent many individuals, and universities represent many professors – individuals and professors whose preferences do not always coincide. In addition, there are methodological limitations in terms of assessing the impact of government programs on corporate-university linkages. For example, it was not until 1986-87 that universities in Ontario began to report corporate research grants and contracts as a separate revenue category. Thus, data on corporate research contracts before 1986-87 can only be obtained from university archives and these files may not be as accurate as the present-day data. Secondly, the type of data that can be obtained from participating companies may depend on how recently the project was undertaken. If the project was undertaken three to five years ago, it would be difficult to determine the specific effects the grant may have had on the company, except at a very general level. The same limitation would extend to the professor who undertook the research three to five years ago.

The results of this preliminary examination of one matching grants initiative suggest that as a method of stimulating additional corporate research contracts in Ontario universities, the use of matching grants in the manner employed by the BILD program, may not be appropriate. This is not to say that the other effects of the matching grants, such as increased research revenues for universities, and the indirect subsidization of corporate research is inappropriate, but that these outcomes do not necessarily contribute to enhanced corporate-university research linkages in Ontario.

NOTES

1 In 1980 the U.S. Supreme Court ruled that the results of research in biotechnology were patentable under U.S. patent law. See *Diamond v Chakrabarty* U.S.C. (1980), 447 U.S. 303. This ruling led to an explosion of interest by American corporations in university based research, particularly in science departments that conducted biotechnology research. Also see Charles C. Caldert, "Industry Investment in University Research" *Science, Technology, and Human Values* Volume 8, Issue 2 (Spring 1983): p. 24.

2 Hereinafter the BILD Matching Research Grant Program will be simply referred to as the BILD program.

3 Letter from Dr. Bette Stephenson, Minister of Colleges and Universities to Presidents of Universities of Ontario, October 15, 1982. IDEA's mandate was to "promote the development of new technologies, to increase the supply of skilled manpower and to facilitate the application of the latest technology to industry" BILD, *Building Ontario in the 1980's* (Toronto: Queen's Printer for Ontario, January 27, 1981), p. 27.

4 The four reasons are fiscal gap, fiscal equity, interjurisdictional spillovers, and enforcement of grantor preferences. See Robin Boadway, (1980) *Intergovernmental Transfers in Canada*

Financing Canadian Federation (2), Canadian Tax Foundation, pp. 41-61. See also Musgrave and Musgrave, (1976) *Public Finance: In Theory and Practice*, New York: McGraw-Hill.

5 A merit good is defined as "goods the provision of which society (as distinct from the individual consumer) wishes to encourage or, in the case of demerit goods, to deter." Musgrave and Musgrave, (1976) *Public Finance: in Theory and Practice*, New York: McGraw-Hill, p. 78.

6 Council of Finance Officers – Universities of Ontario, *Financial Report of Ontario Universities 1987-88* Research Division, Council of Ontario Universities, Volume 1, Universities and Supplementary Volume, November 1988. It must be note that the University of Ottawa does not break out corporate research contracts from corporate research grants. Thus, data on corporate contracts from the University of Ottawa is not represented.

7 For the purposes of analysis, it was assumed that the data provided by these universities accounted for 90 percent of all corporate contract research from 1980-81 to 1983-84. This figure was grossed up to 100% to represent all universities.

8 Fiscal year 1986-87 is the first fiscal year that corporate contract research revenues was explicitly shown as a distinct financial reporting category in the Council of Ontario Universities Financial Reports. The data were previously lumped into a category entitled "other grants and contracts".

9 This problem has been rectified in the URIF program.

10 If a company contract and address was secured from the professor who undertook the research, the questionnaire was addressed to the company contact. If there was no company contact but a company address, the questionnaire was sent to the president or chief executive officer. If there was more than one contact at a company (because of multiple matching grants), the questionnaire was sent to the president or chief executive officer, with a listing of all matching grants awarded and requesting that the questionnaire be sent to the appropriate company contact. The survey was administered in June 1988.

11 Seventy four percent of industry funded R&D in Canada is undertaken by just 100 companies. See The Canadian Institute for Advanced Research, *Innovation and Canada's Prosperity: The Transforming Power of Science, Engineering and Technology* October 1988, p. 56.

12 "Higher Education Resources for Industry, 1988/89" Cambridge, Hobbins Publishing, June 1988.

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